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THE GEOLOGY OF THE ST. HELENS-SCAMANDER AREA, TASMANIA

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(Communicated by Professor S. Warren Carey)

(With 3 Maps)

ABSTRACT

The Scamander Slate and Quartzite consist essentially of a succession of stratified slates, quartzites and sub-greywackes with a few siltstone bands, which probably form part of the Mathinna Group. They contain primitive plants (*Hostimella* (?)) and are regarded to be of Siluro-Devonian age. They are intruded by a Devonian (?) quartz monzonite batholith, and possibly at a later date by St. Marys Porphyrite, which may however prove to be a dacitic flow. At present their structure is confusing; close parallel folding occurs which is overfolded from the west and complicated by numerous minor fault breaks. Major faulting in the area occurred in lower Tertiary, isolating the coastal plain physiographic unit from the hinterland.

The Permian System which follows unconformably has been divided into the following six formations:—

1. Sisters Granule Conglomerate.
2. Lohrey's Gully Sandstone and Calcareous Mudstone.
3. Enstone Park Limestone.
4. Binn's Gully Mudstone.
5. German Town Tillite.
6. Rays Hill Arkose.

The structure of these sediments is controlled by the Mt. Nicholas dolerite sill which intrudes them, and the concomitant faulting developed at the time of its emplacement in the Jurassic.

Lower Tertiary faulting and sedimentation during the Cainozoic resulted in the development of Tertiary wash covering the coastal plain to 350 feet above sea level, and probably the alluvial tin deposits at St. Helens were formed at this time.

Economic considerations reviewed include potential tin, tungsten, and copper deposits.

INTRODUCTION

The boundaries of the area mapped are defined by the co-ordinates 600,000 yards to 610,000 yards east and 800,000 yards to 910,000 yards north zone on the International Grid on sheet No. 4 of the 4-mile State map of Tasmania. The total area mapped is about 85 square miles.

The object of the survey was to produce a regional geological map of the area for submission to the University of Tasmania as a B.Sc. Honours Thesis. It was undertaken during 1952.

Aerial photographs were used to complete a base map from a slotted template layout controlled by trigonometric fixes, and for the plotting of field data. The aerial photographs were not amenable to photogeological interpretation, owing mainly to the regular development of topographic features by the systematic trellised drainage in the area, which gave rise to a monotonous repetition of hills and gullies of similar type. Photographs reveal only a few structural features such as some major faults. No characteristic photo patterns can be recognized from different rock and soil types or as a result of differential erosion.

Rock outcrop is poor, even though the soil cover is in general thin or absent. Disintegration of the short-jointed Scamander Slate and Quartzite has resulted in the shedding of a veneer of angular rock fragments, which conceals the underlying rocks. Consequently, boundaries between different rock types are indefinite, and this with frequent minor breaks results in confusion. The shattered nature of the terrain suggests a complexity of structure too detailed to be solved by this investigation.

Since the terrain is of poor quality, it is of little value for land settlement. Apart from the Tasman Highway, and the Golden Fleece Rivulet, the Upper Scamander and German Town roads, only a few access tracks exist to areas attractive to the timber miller.

Specimen and slide numbers referred to in this paper are of rocks kept in the Geology Department Museum at the University of Tasmania.

I am indebted to the Tasmanian Mines Department for the loan of microscope slides belonging to Twelvetrees (1911), and for access to unpublished reports.

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PHYSIOGRAPHY

Partially Rejuvenated Coastal Plain

In this unit rejuvenation has not resulted in so deep a dissection of the plain as it has in the hinterland. It extends the length of the area from Falmouth to St. Helens and further north, tapering from north to south; it is two to three miles wide at Diana Basin, and only one to two miles at Scamander. It dips gently east and seawards from its western margin, where it is elevated about 350 feet and abuts against the Coastal Range.

Subsequent rejuvenation has dissected the thin unconsolidated Tertiary sediments which cover the coastal plain so that youthful valleys of 100 feet to 150 feet depth have developed towards its western margin. Where denudation has been more extensive, the sediments have been completely removed, and the structure of the Scamander Slate and Quartzite and granitic rocks again controls the physiographic development, so that it then follows a similar pattern of development to that of the hinterland.

The coastal margin of the plain is lined with beaches, dunes and occasional rock outcrops. Dune development is more extensive towards the northern end where at St. Helens Point the dunes extend one-third of a mile inland. No elevated water-cut beaches occur.

The prevailing wind is northerly, which keeps the sand in constant movement, and is one factor preventing the migration of dunes inland.

Other coastal features developed along the plain are lagoons and barred basins, which include Hendersons, Wrinklers, Moriaty and Diana Basin These are filled by drainage from the hills to the west, and their outlets are barred like those of all creeks along the coast and that of the Scamander River. The water percolates below these sand bars into the sea, and during the wet season they dam back considerable quantities of water. Some low-lying zones are peaty with button grass, and sometimes marshy conditions prevail when drainage is poor.

To the south of Falmouth the St. Marys Porphyrite shelves flatly into the sea from the slopes of St. Patricks Head. In this area the coastline is essentially one of porphyrite outcrop with occasional small inlets and beaches.

Strongly Rejuvenated Hinterland

Topography

The second unit, the hinterland, forms a low mountainous region. This physiographic type extends west from the Coastal Range beyond the western boundary of the area. It is interrupted by granitic terrain to the north of the Golden Fleece Rivulet, and continues as far south as the northern slopes of the Mt. Nicholas Range.

Its youthful topography has been moulded by a trellised drainage pattern forming typical V-shaped valleys. On the whole the hills and ridges are slightly higher in the west. The Coastal Range averages 800 feet to 1000 feet, and the Scamander Tier reaches nearly 1500 feet in places. This suggests that if a pre-lower Tertiary plain existed, it dipped gently eastwards.

The Coastal Range runs roughly parallel to the coast, having an axial trend a little west of north. Scamander Tier converges to within a mile of the Coastal Range at its northern limit adjacent to Flagstaff Hill, and is terminated in the south by the Scamander River, 2½ miles west of the Coastal Range. This general north-south trend of the ranges and country may indicate that lines of weakness developed parallel to the coast.

All the hills are of the narrow straight ridge type and are invariably steeper on the south-west side with gentler slopes on the north-east flank.

The higher and more rugged peaks are dolerite of St. Patricks Head to the south, and the Mt. Nicholas Range, and the North and South Sister in the south-west corner of the area. They expose the usual columnar and precipitous outcrops so characteristic of Tasmanian physiography. In this south-west corner of the area, physiographic development has been controlled by columnar dolerite and modified by the Permian sediments. At German Town solution of Permian limestone undermined the terrain, causing subsidence in a number of places.

Drainage

The development of the trellised drainage pattern has been influenced by structural features of the rocks, such as prominent jointing and faulting, rather than by differential erosion of the various rock types of the area. This is especially so with the Scamander Slate and Quartzite intruded by granitic rocks.

A series of roughly parallel faults has controlled the development of many of the gullies in the St. Marys Porphyrite. This is demonstrated in the contact zone between the porphyrite and the Scamander Slate and Quartzite.

The major streams draining the area are the Scamander River and the Golden Fleece Rivulet, and a small portion of the area to the north of St. Helens is drained by tributaries of the George River. Apart from these, numerous coastal creeks drain eastward into the sea, while those west of the Coastal Range usually flow north or south and empty their contents into the Scamander River. The most important of these is Eastern Creek, which drains the valley between the Coastal Range and Scamander Tier.

Similarly, to the south of the Scamander River, the ridges and creeks run parallel to the coast from the hills around German Town, and the creeks drain northwards into the Scamander River. The eastern slopes from German Town, and the north-eastern slopes from St. Patricks Head, are drained by creeks flowing seaward, which invariably are controlled by faults.

Constable and Ferntree Creeks drain the northern slopes of the Scamander Tier and flow north-east into the Golden Fleece Rivulet.

George River is the longest river in the extreme north of the area draining the relatively low granitic country, and has its outlet in George Bay. The greater part of its water is derived from north of the area under review.

The Scamander River is the major river in the area. It rises in high ground some miles west of Hogan's Track, and flows south-east until it unites with the Avenue River about 8 miles from the sea. From here it pursues a more or less easterly meandering course, and at the coast it is estuarine. In this part of its course it crosses the general trend of the strata, and flows nearly at right angles to the direction of the mountain ranges. The present mouth has been developed along a prominent fault line in the Scamander Slate and Quartzite, whose steep rocky banks plunge below the water line without the formation of shingle or sandy beaches. The sand bar at its mouth is only open a few times during the year and it then becomes tidal for about 4 miles upstream.

It is considered that its present mouth is not the original outlet to the sea. Prior to Tertiary deposition it flowed along the first mile of the Upper Scamander road and then along the length of Henderson's Lagoon, probably finding an outlet to the sea at Falmouth. Either Tertiary sediments have filled the old Scamander River bed and forced it to exploit the fault line along which it now flows to the sea, or, more probably, this course was initiated by some form of river capture. Evidence of its old course is recorded by gravels 10-20 feet above sea level.

The sealing off of the outlet of the Scamander River has caused its adjacent lower reaches to become extensively silted up and consequently to develop ox-bow lakes and broad silt flats which are quite fertile.

Physiographic Development

The completeness of the cycle of erosion before the land surface was inundated by Permian seas cannot be determined exactly from the fragmentary evidence available. Permian sediments are found to cap a number of the hinterland topographic highs and their altitude is approximately the same.

The Permian on the coastal plain near Falmouth (884,250-603,550) is about 1300 feet below its equivalent horizon at German Town, and occurs too far west to be downthrown by a single fault along the eastern base of the Coastal Range, which separates the two physiographic units. This infers that the separation of the coastal plain from the hinterland is not due to a single fault. Field and aerial photograph evidence indicates a complex series of step faults in the St. Marys Porphyrite contact-zone causing the relative displacement of the Permian.

The Mesozoic land surface was possibly peneplained before the deposition of a veneer of Tertiary wash on it, and before lower Tertiary faulting occurred. This is shown by the fact that the Tertiary wash is fairly even in thickness through a large range in present attitude, to 350 feet above sea level on the coastal plain. Gentle east dip of this pre-Tertiary erosion surface is also shown by the hills being slightly higher in a westerly direction.

There is no doubt that lower Tertiary faulting has exerted a marked control on the physiographic development in the area, resulting in the general north-south trend of physiographic features. It elevated and tilted the coastal plain separating it from the hinterland, which represents a more strongly rejuvenated portion of the Mesozoic land surface, and hence shows more deeply cut valleys.

SILURO-DEVONIAN SYSTEMS

Scamander Slate and Quartzite

For the purposes of this paper the oldest succession of sediments in the area will be referred to as the Scamander Slate and Quartzite, pending further information regarding their correlation with rocks in other parts of the State. It may be a formation, but not enough is known to define it as such. The highest and lowest members are not known, but possibly a fairly complete sequence is exposed in the Upper Scamander road cutting and along the coastal outcrop one mile north of Diana Basin.

Although the Scamander Slate and Quartzite is at present considered as a separate unit, it will probably later prove to be the same as, or part of, the Mathinna Group (Hills and Carey 1949). There is a marked similarity between the two, and similar rocks appear to continue in an unbroken line to Mathinna and north through Mt. Victoria to Warrentinna and Gladstone. Little aid to correlation is available from fossil remains.

The Break of Day Rivulet between Mt. Nicholas and St. Marys Pass marks the southern limit of the Scamander succession and in this parallel the sediments pass beneath the dolerite of the Tiers. The succession extends north from the St. Marys Porphyrite contact, forming the main portion of the hinterland, until it is cut off by granitic rocks in the St. Helens area, along the line of the Golden Fleece Rivulet.

Exposures of the Scamander Slate and Quartzite are not good, and as mentioned the best sections occur in the Upper Scamander road cuttings, and along a coastal outcrop one mile north of Diana Basin. Apart from these, exposures are confined to the occasional precipitous valley wall. The paucity of outcrop results from the disintegration of indurated bands of stratified sediment, which are short-jointed and cause an extensive veneer of angular rock fragments to cover slopes in place of soil and rock outcrop. Accumulations concentrate on valley floors after migrating down grade. Talus is usually quartzite, though accumulations of slates also occur in places and these in some instances reflect the nature of the hidden rock type.

In general, the Scamander Slate and Quartzite, where exposed, form a remarkably simple succession of sediments. They are either massive and structureless in outcrop or have monotonously constant structural features. They comprise a succession of closely stratified slate, siltstone, quartzite and sub-greywacke.

Intraformational Structures

Minor intraformational structures include depositional rolls and corrugations, which occur between slate and quartzite horizons. They develop in both slates and quartzites along planes representing changes in lithology. The direction of the rolls is usually parallel to the strike, but in a few cases it is seen parallel to the dip.

Occasional slump structures are seen, especially in the sandstone. An example of this structure occurs in a band of sandstone in an Upper Scamander road cutting near the big bend of the Scamander River, and it suggests a movement forward and westward.

Current bedding only occurs in a few narrow bands of quartzite, and indicates currents from the east in places where the beds are not overturned.

A distinctive breccia occurs close to the St. Marys Porphyrite contact, and along the greater part of its length. It has not been seen elsewhere in the area, though it appears to bear no apparent structural relationship to the Scamander succession or the porphyrite. Although it is well developed, its occurrence is unpredictable and in some places it is limited or absent. It may appear as isolated pockets of recemented angular debris, filling joints and other apparent cavities in the Scamander Slate and Quartzite. It contains angular fragments of quartzites, but no fragments of porphyrite. Its fabric and metamorphic character (see below) discount the possibility of an overthrust of the porphyrite on to the Scamander Slate and Quartzite. If it is a fault breccia its sedimentary character, metamorphic grade, and exclusive association to the St. Marys Porphyrite contact zone remain an enigma. The only other possibility is that it is a breccia of recent origin.

Fossils

Fossils are rare. Plant remains include the primitive plant *Hostimella* (?) described by Cookson (1936). She considers that it can be assigned to an upper Silurian age. The pieces preserved are fragmentary, and the best specimens are found in the fine to medium grained carbonaceous sub-greywackes and slates.

Other dwarf fossils occur in lenses of porous intra-formational conglomerate. They are exceptionally rare and include bryozoans, corals, brachiopods, and crinoid columnals as moulds. The fossils indicate a place of burial and not growth.

Provisionally the age of the Scamander Slate and Quartzite may be considered to range between middle Silurian and middle Devonian, but are possibly lower Devonian.

Depositional Environment

It is impossible to give any estimate of thickness of the succession. The sediments were probably deposited in a marine basin in the upper Silurian or lower Devonian. The source of the material was possibly a low mountain range to the east of the area. The intraformational structures indicate currents from the east. The depositional environment would not be congenial for the development of a large unbroken thickness of sediments unless sedimentation took place in a slowly sinking basin. Alternately the oscillatory shore line gave rise to deposition of thinly interbedded stratified shales, siltstones, sandstones and sub-greywackes. Minor depositional structures indicate that the floor of deposition was sloping to the west.

Petrography

Most specimens come from the Upper Scamander road cuttings, though some have been collected from other parts of the area.

Petrological examination of specimens reveals a close similarity in composition between rock types. All except the quartzite differ mainly in texture and granularity, ranging from sub-greywacke siltstones to fine and medium grain sub-greywacke.

The quartzites are sometimes irregularly fractured (4763, 4727 and 4725), which probably results from the different physical reaction of their texture to stress as compared with the sub-greywacke siltstone textures.

No pyroclasts or other volcanic rocks are seen in the succession

All these sediments show changes due to low grade thermal metamorphism, which was not sufficient to destroy their original texture. Except for localized contact zones, the change was uniform.

Petrologically, the sediments can be classified into three groups according to table 1.

The Contact Between the Scamander Slate and Quartzite and the St. Marys Porphyrite

The metamorphic character of the Scamander succession adjacent to the St. Marys Porphyrite contact is significant when considering the origin of the porphyrite.

Specimens of fine-grained sub-greywackes (4759, 4653 and 4656) cannot be collected *in situ* within 10 feet of the porphyrite contact. In general, sedimentary outcrops are structureless, but at 885,950-601,975 bedding strikes 227° and dips 88 SW. The specimens show little more than low-grade thermal metamorphism consistent with those listed in Table 1. Slight baking of the immediate contact sediments may have occurred, but this contact surface is concealed under rubble.

A large fragment of country rock (4651) caught up within the porphyrite contact zone shows stronger thermal alteration. Porphyroblasts of quartz and felspar occur in its fine micaceous matrix. The granoblastic fabric of the groundmass consists of interlocking quartz grains, some of which are cracked and show wavy extinctions. A few large round waterworn (?) grains of quartz remain and measure up to 1·2 mm. in diameter. Plagioclase grains measure up to 2 mm. in size, many are cracked and altered to sericite. The groundmass contains small grains of felspar, quartz, green biotite and flecks of chlorite. The original sediment was possibly more argillaceous than 4759, 4653 and 4656 (which occur 10 feet from the porphyrite contact) but it may be partly felspathised.

Sections of the breccia referred to on this page show it consists of recemented angular fragments of Scamander quartzite. The matrix in 4661 and 4662 is similar to that of the sub-greywacke siltstone listed in Table 1, except some slides cut by siliceous veins. Resolution of grains in the matrix is poor. The matrix consists of minute quartz grains, fine micaceous needles and flecks of carbonaceous material. Once again, the alteration is low thermal.

TABLE 1

Field Name.	1. SUB-GREYWACKES. Slates and Sub-greywackes.	2. SUB-GREYWACKE SILTSTONES. Claystones and Siltstones.	3. SANDSTONES AND QUARTZITES. Sandstones and Quartzites.
GRADE	Arenite. Fine grained—0·06 mm. to 0·25 mm. Medium grained—0·25 mm. to 0·6 mm.	Lutite. Even grained 0·01-0·04 mm.	Arenite. —
FABRIC	Sedimentary.	Sedimentary—occasional siliceous veins—some banded with orientated mica laths (4753, 4754). Others spotted—perhaps as a result of incipient centres of crystallization or mica development (4705).	Sedimentary—some quartzites are inter-granular (4763, 4731). Grains often show parallel (4763) and irregular (4727) fracturing.
SORTING	Poor.	Good.	Poor.
ROUNDING	Angular to sub-angular.	Angular to sub-angular.	Sub-angular to sub-rounded.
MINERALS AND HEAVY MINERALS	Quartz 60-80% shows part or complete reconstitution of grains and some of which are larger than the matrix granularity. Biotite and muscovite—small and large grains. Chlorite and sericite—small amounts as needles and laths. Felspar, iron ore, sphene tourmaline and apatite grains are rare.	Resolution of some grains impossible. Quartz—grain size 0·02-0·04 mm.—show partially reconstituted grain margins. Few large grains to 0·1 mm. size. Chlorite, muscovite splinters and little biotite (4754). Apatite and zircon grains are rare (4758).	Quartz-grain size 0·2-0·6 mm. Tourmaline—large rounded grains (4763, 4731). Biotite (4728). Muscovite—few grains (4727, 4731 and 4730). Occasional zircon grains and pyrite cubes.
ROCK FRAGMENTS	Mainly quartzite 1-10%.	—	Quartzite in 4763, 4727 and 4728.
MATRIX	Micaceous from original argillaceous material 10-30%.	Micaceous 30%. Carbonaceous in some cases 10-20%.	Little interstitial mica to interlocking quartz grains 0-5%.
CEMENT	Some rocks ferruginous 1-5%.	—	Up to 10% ferruginous in 4727.
COLOUR	Buff, red-brown, blue-grey and black micaceous and carbonaceous varieties.	Green, purple and brown. Light to dark-grey banded.	Buff tending to darker colour with depth.
BEDDING	Laminated, fissile and some typically slaty.	Poorly cleaved, laminated in places.	Sandstones and argillaceous sandstone—massive and structureless. Indurated quartzites—strongly short jointed. Stratified beds with slates and sub-greywackes.
OTHER FEATURES	Gas bubbles in some quartz grains. *Hostimella* (?) occurs in carbonaceous sub-greywackes.	Siliceous and micaceous banded grey varieties occur, some with clay pellets.	Some quartz grains contain numerous inclusions.
METAMORPHISM	Very low thermal.	Very low thermal.	Low thermal in places slight crushing of quartz grains.
ORIGIN OF MINERAL GRAINS AND ROCK FRAGMENTS	Derived from metamorphic and igneous rocks.	—	Derived from metamorphic and igneous sources.

TABLE 2

	Rays Hill Arkose	German Town Tillite.	Binn's Gully Mudstone.	Enstone Park Limestone (Calcilutite to Calcarenite).	Lohrey's Gully Sandstone and Calc. Mudstone.	Sisters Granule Conglomerate.
THICKNESS (FT.)	70	20	120	60	55	15
GRADE	Arenite medium to fine grained.	Lutite medium grained.	Lutite coarse grained.	Lutite (arenite). Coarse to fine grained.	Arenite, medium-grained lutite, coarse grained.	Rudite fine grained.
SORTING	Fair.	Poor.	Good.	Good.	Fair to good.	Good.
ROUNDING	Angular to sub-angular.	—	Sub-angular to sub-rounded.	Angular to sub-rounded.	Angular to sub-angular.	Sub-angular to sub-rounded.
MINERALS	Quartz, muscovite and 40% felspar.	Quartz, felspar, calcite.	Quartz and felspar.	Calcite.	Quartz, felspar and chlorite—glauconite (Brill. 1955).	Quartz and felspar.
ROCK FRAGMENTS	Quartz, quartzite sub-angular to sub-rounded.	Common water-worn, angular, mostly faceted.	Rare.	Common mostly small angular, many rock types.	Common quartz (colourless grains) schists, &c.	Uncommon.
CEMENT	Ferruginous.	—	Calcareous.	—	—	Argillaceous (Kaolin) and Ferruginous.
COLOUR	Grey.	Grey.	Grey to buff.	Grey to cream.	Yellow to green.	White to buff.
BEDDING	Massive.	Flaggy to massive.	Shaly to massive.	Flaggy to massive.	Shaly to massive.	Massive.
OTHER FEATURES	Contains erratic pebbles and exposes bow fronted and domed outcrops.	—	Clay pellets and stray pebbles.	Relatively pure, stray pebbles and cliff faces rich in fossils.	Becomes coarser grained upwards. Numerous colourless quartz grains.	Colourless to milky quartz.
FOSSILS	Contain a few marine and plant fossils.	Contain a few marine and plant fossils.	Some marine fossils.	Corals, Bryozoa, *Martiniopsis*, spiriferids, productids, *Lyroporella*, aviculopectinids. *Streblotrypa*, *Eurydesma cordatum* var. *sacculum*.	Unidentifiable fossils.	Unfossiliferous.

Considering the overall thermal metamorphism recorded in the Scamander succession, contact effects are almost negligible in the contact zone as a result of emplacement of the St. Marys Porphyrite. This feature of the porphyrite suggests a flow origin for this igneous mass.

PERMIAN SYSTEM

Distribution of Sediments

The Permian sediments occur in the south-western corner of the area, and lie unconformably on the St. Marys Porphyrite and Scamander Slate and Quartzite. Evidence is fragmentary, since the restricted sequence of sediments occurring in the area has been disrupted by the injection of dolerite dykes and sills forming the Mt. Nicholas Range. They form part of a suite ranging from ortho-quartzite to limestone. One exposure represents an unbroken sequence occurring at 880,650-600,750 to 880,750-600,550 on the southern flank of Rays Hill. The Permian also occurs further east of this, in the Enstone Park Estate at Falmouth (884,250-603,660) where it is relatively lower by 1300 feet than the equivalent beds at German Town, as a result of the lower Tertiary faulting.

Sub-Division into Formations

The section at 880,650-600,750 to 880,750-600,550 exposes six formations. The remainder of the Permian outcrops are isolated blocks in the dolerite intrusive which constitutes Rays Hill. Sub-division into formations from the fragmentary evidence available shows the succession to be (see table 2).

"Dolerite Sill".
Sisters Granule Conglomerate.
Lohrey's Gully Sandstones and Calcareous Mudstone.
Enstone Park Limestone.
Binn's Gully Mudstone.
German Town Tillite.
Rays Hill Arkose.
Basement—Scamander Slate and Quartzite and St. Marys Porphyrite.

TERTIARY SYSTEM

Distribution of Sediments

The unconsolidated Tertiary wash on the coastal plain, and the partly consolidated Tertiary sediments of George Bay, lie unconformably on Permian sediments, granitic rocks and the Scamander Slate and Quartzite. The cover at Diana Basin is three miles wide, compared with one and a half miles in the vicinity of Scamander, tapering from north to south, and finally petering out near Falmouth.

As mentioned, an east-west section of Tertiary on the coastal plain shows that the thin cover persists as a veneer on a gentle east dipping grade from the base of the Coastal Range to sea level. At the foot of the Coastal Range, Tertiary sediments remain only on crests of hills and spurs, and on the coast the basement rocks are frequently uncovered.

The cover in the Falmouth area is not nearly as thick as it is at St. Helens, where extensive sediments 150 feet thick accumulated, concealing the basement rocks completely. In the George Bay area the beds are relatively thick and consolidated, possibly because a barred basin may have existed there during deposition.

Lead development in the St. Helens area probably belongs to this same epoch.

The wash on the coastal plain consists of a veneer of unconsolidated waterworn pebbles of quartz and quartzite scattered in a loamy soil, with numerous isolated occurrences of bedded ferruginous quartz granule conglomerate. In many places is found lining the base of the Coastal Range delineating the coastal plain physiographic unit from the hinterland. This represents the highest occurrence and is about 350 feet above sea level. In many places it is found on crests of hills where it is bedded (903,330-610,850), or current bedded (905,180-606,040 and 904,860-605,600) and which also contains numerous poorly-sorted, angular or waterworn quartz pebbles, as well as fragments of slates and quartzites from the Scamander succession, in a ferruginous cement. Poor sorting and rounding of quartz grains indicate a fairly local source for this material.

South of the Golden Fleece Rivulet (905,110-602,100) a large U-shaped area of wash occurs which may be Tertiary. Here, the ferruginous granule conglomerate is found some 250 feet above sea level, again on the summit of hills. The axis of this sedimentation runs roughly parallel to, but a little east of Constable Creek. It extends southward and just west of the northern end of the Coastal Range, and differs from the coastal plain wash in the almost complete absence of the white waterworn quartz pebbles, and the less extensive development of loamy soil cover.

The cover in this area consists of sub-angular to sub-rounded, poorly sorted fragments of Scamander quartzites. Consequently, the ferruginous granule conglomerate contains sub-angular fragments of Scamander Slate and Quartzite in place of the rounded quartz pebbles seen on the coastal plain. This probably reflects different source material from that of the coastal sediment.

Age and Origin

The most important considerations in the determination of the origin and age of the wash are its distribution (it is confined to the coastal plain), and the regularity with which it appears to lap up to the 350 foot contour on the eastern flank of the Coastal Range. The height of its occurrence above sea level and consistency of distribution eliminate the possibility that it resulted from eustatic fluctuations of sea level, especially those relating to the Pleistocene glaciation. It is unlikely, but not impossible, that it represents remnants of an old ferrugineous crust, whose formation was contemporaneous with lateritic crusts developed in other parts of the State, and that it has been removed from the hinterland by subsequent erosion.

No evidence exists to indicate that these sediments have been faulted, and it appears that conditions of sedimentation reflect their formation during or after lower Tertiary faulting. The exact origin and process of development of the wash remains unknown, but if it were developed during that time, it is either a flood plain deposit or marine wash elevated and isolated from the hinterland by faulting.

The absence of marine fossils and foraminifera, the poor sorting of the unconsolidated sediments, and the sub-angular to sub-rounded character of the rock fragments, all suggest fluvial or flood plain origin from local source material rather than marine deposition. Also, no elevated coastal physiographic features are apparent or preserved in the coastal plain area.

Alluvial Sediments

Alluvial tin-bearing localities differ in a number of places. At 906,050-602,060, an old tin sluicing area, sluicing exposes poorly sorted slate and quartzite fragments in a matrix of yellow ferruginous clay deposited on Scamander Slate. This material is angular to sub-rounded, and possibly not transported far from its source.

Deposits along the Upper Scamander road have been worked for alluvial tin and these probably occupy the old course of the Scamander River when its outlet was in the Falmouth area.

In the St. Helens area the thickness of the lead deposits changes, increasing towards their mouth. Nye (1933) estimates that Thureau's Lead is 200 feet thick in the north-south portion of the Golden Fleece Rivulet. The bottom of the lead is below sea level where it crosses Medeas Cove and is some 200 feet above sea level near Goshen. These ferruginous and argillaceous quartz granule conglomerates, and are characterized by lead deposits in their superficial layers (Nye, 1933). He also states that it appears that the upper beds or higher horizons of Thureau's Lead were tin-bearing to a much greater extent than the lower ones, and that this infers that the land surface remained at much the same level for some time during concentration in the upper beds, or the greater part of the primary tin was not uncovered until the formation of the upper beds of the lead, or finally, the upper levels of the original leads have been denuded and as a result the tin has been concentrated in 5 to 10 feet of derived gravels.

At present no accurate information exists to date the leads. Provisionally they may be considered Tertiary and equivalent to those which are covered by Tertiary basalt flows in the Derby area, though they need not necessarily be related to those deep leads. The fact that nowhere are the leads reported to be dislocated suggests that they are not earlier than the lower Tertiary faulting.

Whether any relationship exists between the leads and eustatic fluctuations of sea level in the Pleistocene seems doubtful, though some reworking of deposits may have occurred. If any Pleistocene sediments exist in the area, unravelling them from Tertiary deposition on the scale of mapping undertaken would be impossible. Hence, in localities such as George Bay disentangling of Cainozoic sediments is not easy because of the uniformity of source material.

The rapid erosion and modification of the land surface following lower Tertiary faulting has been suggested by S. W. Carey (personal comment) as the logical time when lead development could take place, and ensuing sedimentation could comply with the controlling factors of tin source and deposition.

RECENT

Alluvium covers the area in a number of places, especially river flats and flood plains. Such alluvial flats occur at Binn's Gully near Falmouth, the lower reaches of the Scamander River, and also an extensive development surrounds St. Helens.

IGNEOUS GEOLOGY

The Coastal Range Quartz Monzonite

Field Observations

The main exposure of quartz monzonite in the area roughly corresponds to the axis of the Coastal Range, crossing it diagonally from its eastern side in the south to its western side in the north. At the Constable Creek tungsten mine, the granitic outcrop possibly represents the apex of a cupola. Granitic rocks also extend from the Golden Fleece Rivulet beyond the northern boundary of the area under review. This extension constitutes the southern portion of a large granitic mass which passes north-west to Derby and as far north as Gladstone. Numerous other exposures occur, especially along the coastal plain. Twelvetrees (1911) reports that Paddys Island and St. Helens Island appear to consist of light-yellow muscovite granite, similar to an occurrence which crops out on the coast at St. Helens Point.

The area of granite mapped is 7 square miles. It intrudes the Scamander Slate and Quartzite with sharp transgressive contacts.

The coastal section, 1 mile north of Diana Basin from 903,490-610,850 to 903,650-611,050, reveals that the magma intruded by plucking slabs of country rock from the roof and wall of the magma chamber, possibly by piecemeal stoping (Daly, 1933), and assimilating these xenoliths in its upward migration. Xenoliths in all stages of assimilation were suspended in the magma when it consolidated, and gave rise to localized zones of contamination within the granitic rocks, now recognized by zones enriched in ferromagnesian constituents. Such zones occur in both central and marginal portions, but are more common towards the margins. Different localized modifications of texture and mineral content in the field, at first appearance, give the impression that the batholith is a heterogeneous acid igneous mass, since such zones have no definite boundaries between them.

At 910,910-605,620 and 911,140-605,820, orientation of ferromagnesian minerals is a localized effect. This would result from flow in the magma (Balk, 1937), or from injection of the magma under lateral pressure, giving it a gneissic structure as seen at 911,010-605,020, where foliation is 330°.

Both quartz monzonite porphyry and porphyritic quartz monzonite may be found. At 910,300-608,400 to 910,600-608,300 phenocrysts in the porphyritic monzonite are orientated 190° and average 4 cm. long, with some as large as 7 cms.

Different phases of granitic activity have been recognized. At St. Helens Point the biotite granitic type has porphyritic phases as elsewhere, and also contains xenoliths. Boulders of basic rocks, similar to those seen intruding the quartz monzonite north of Diana Basin, occur in this region too. Pegmatite phases associated with the muscovite granitic type intrude the biotite granitic type of the area, and it is evident that this leucocratic phase is the younger.

Numerous apophyses are associated with the Coastal Range quartz monzonite in its marginal zone. These are aplitic, pegmatitic and dioritic dykes and sills. The few aplitic dykes do not extend more than a chain from the contact, as demonstrated by that at 903,500-611,000 which strikes 125° and tapers from one foot to an inch in 75 feet. The diorite porphyry dykes and sills are referred to below as they are a late phase of the quartz monzonite intrusive.

The temperature of intrusion of the quartz monzonite was sufficient to plastically deform the immediately adjacent country rocks, yet induced only low-grade thermal metamorphic changes and minor contact effects in them.

A rough estimate of thickness of the overlying country rocks, at the time of intrusion, is a minimum of 5000 feet. This is a doubtful estimation derived by projecting the base of the St. Marys Porphyrite north and calculating its height above the batholith. Thus, the assumptions are made that little erosion occurred between intrusion of the granitic rocks and emplacement of the St. Marys Porphyrite and that the St. Marys Porphyrite has not been subsequently tilted.

Many granitic exposures show typical spalling, mural jointing and domed surfaces. Weathering is extensive in some localities, especially north of the Golden Fleece Rivulet. Great thicknesses of decayed granitic rock, which show original structural features, are exposed in some road quarries. It is for this reason that finely disseminated tin can be hydraulically mined *in situ* from the decayed granite.

Petrography

The Coastal Range quartz monzonite is a light-grey, medium to coarse grained rock showing facets of felspar and quartz, with a plentiful sprinkling of biotite flakes.

In section the rocks are typically granitic, except for 4673 and 4666 which have an almost granoblastic character, and are finer than average grain size. There are a number of different textural modifications but these are localized features. Finer aplitic textures are rare, but coarser porphyritic ones are common. The fabric of the porphyries (4736, 4723 and 4715) shows felspar and corroded quartz phenocrysts. Other localized textural modifications include graphic intergrowth in 4692 and 4690, and the perthitic texture in 4675 and 4701. Poikilitic and myrmekitic textures occur in 4678, where phenocrysts of microline contain small inclusions of plagioclase and quartz grains.

The general texture of the quartz monzonite is not typically monzonitic, but approximately equal proportions of potash and plagioclase felspars and abundant quartz give the granitic rock a quartz monzonite composition.

Directional trend of ferromagnesian minerals corresponds to foliation in 4666 and 4668. Other stress features are localized minor effects such as slight shearing and the development of chlorite in 4668 and the crushing or localized mylonitization in granitic rock 4691.

Potash felspar and plagioclase in slides of granitic fabric can be as large as 3 mm. Phenocrysts are larger than this in the porphyries 4703 and 4666 and in the porphyritic quartz monzonite they are usually of potash felspar rather than plagioclase. Zoning in plagioclase is more characteristic of the phenocrysts than it is of ordinary grains, and adjacent zones differ only slightly in composition, alternating rather than becoming progressively more acid. Plagioclase shows slight to extensive alteration, and this is especially noticeable in the zoned crystals which are normally completely altered. In some a particular zone may be altered (4766, 4697 and 4715), and in 4766 the core of a perfectly zoned crystal has been completely altered to sericite, while the outer marginal zone is fresh plagioclase. This selective zone alteration indicates changes in the magma during plagioclase crystal development. Evidence in 4708 of twin lamellae being ruptured, probably reflects movement in the magma during crystallization. Plagioclase composition determined by extinction angle measurement of twins according to the albite law, or combined Carlsbad-albite laws, indicates a remarkably consistent composition within the range $Ab_{65}An_{35}$ and $Ab_{55}An_{45}$, and therefore is always andesine. The average composition for all slides examined was $Ab_{56}An_{44}$. The average relative abundance of plagioclase by visual estimation from 40 sections is 30 per cent.

The consistent composition of plagioclase in all specimens of granitic rock types examined probably indicates their close affinities to one another. Apart from the extremely basic phases, andesine is the composition of the plagioclase whether determined from pure quartz monzonite or from zones of the original magma showing differing degrees of contamination.

In the porphyritic quartz monzonite variety, potash felspar invariably occurs as phenocrysts, although this is not the case with the quartz monzonite porphyry. In the even-grained granitic textured rocks it forms interlocking grains with quartz, and like plagioclase, is rarely fresh. Microcline is the usual potash felspar present, although a few grains of orthoclase have been recognized. Potash felspar was often recognized by using staining tests (Chayes, 1952). Grains average 2 mm. in size in the quartz monzonite and in the porphyritic quartz monzonite phenocrysts reach a maximum size of 1 cm. As mentioned, in field exposures of the same rock, phenocrysts, as large as 7 cm. have been recorded (910,800-608,400 to 910,600-608,300). The average relative abundance is 30 per cent determined by visual estimation from 40 slides. As in the plagioclase, the porphyritic texture of some slides made estimations unreliable.

Quartz occurs as anhedral grains interlocked with felspar and ferromagnesians in slides with granitic fabric, and as euhedral phenocrysts with corrosion embayments in the marginal porphyries (4768, 4715, 4736 and 4723). Grains up to 1 cm. occur in the porphyry but in the porphyritic quartz monzonite they average 5 mm. as part of the granitic groundmass and never form phenocrysts. Many grains are fractured with irregular cracks (4675). In the 40 sections examined quartz averages 40 per cent.

Biotite is the dominant ferromagnesian mineral in the uncontaminated quartz monzonite and in many sections it is the only dark mineral present. In the porphyritic quartz monzonite it occurs in the groundmass and in the porphyry it forms phenocrysts (4700). These are usually anhedral flakes, though sometimes laths are present. Biotite grains interlock with other mineral grains of the quartz monzonite as a minor primary constituent. In some instances, flakes are bent (4715) and in 4666 and 4668 distinct orientation of the biotite flakes reflect foliation seen in the field. It is nearly always the pleochroic light to dark-brown variety with a 2 V about 14° (4703). In the quartz monzonite it consistently constitutes 5 per cent of the rock.

Alteration of biotite to chlorite along cleavage planes results in bands of biotite alternating with chlorite (4678, 4675 and 4766). Other grains show alteration veins of chlorite (4715), while others still are completely altered to chlorite (4736 and 4768). Biotite in 4684 has developed along the cleavage traces of felspar which indicates its later development.

Very few accessory minerals are present in the Coastal Range quartz monzonite. They include a few small grains of sphene, apatite and magnetite. Pyroxene is never seen in the uncontaminated granitic rock.

Secondary Alteration and Pneumatylosis

Deuteric alteration affected most minerals at some time or another during the later stages of crystallization. In part, this may be responsible for minor modifications in composition of the granitic rocks. The effects have already been described with respect to selective saussuritization of felspar grains and alteration of biotite flakes to chlorite.

Amphibole in zones of contamination is altered to epidote while in other cases it is altered to calcite and chlorite as in 4708, 4693, 4691, 4694 and 4695, and in 4736 hornblende and pyroxene are pseudomorphed by calcite and chlorite. In a few slides (4674, 4675, 4684 and 4715) hornblende is an accessory mineral of the quartz monzonite, possibly resulting from localized deuteric alteration. Epidotization has occurred in some other slides (4664). Muscovite is widespeard, especially in the Constable Creek mine area (4765, 4701 and 4702) and other zones of mineralization (4734, 4672 and 4764). This probably results from gneissenization the more leucocratic granitic type at St. Helens Point. Such zones are particularly susceptible to weathering and have been deeply decayed as a result.

Crystallization of the Magma

The history of plagioclase development and zoning, dislocation of twin lamellae, bending of biotite flakes, and irregular cracking of quartz grains suggests that a liquid magma was injected and movement probably occurred during its consolidation. Corrosion embayments in the quartz phenocrysts definitely indicate a fluid origin for the marginal quartz monzonite porphyry. Halts in crystallization and changing composition of the magma during consolidation are also indicated by the selective zoning and alteration of felspar and biotite minerals.

The petrological investigation in association with field evidence provisionally indicates that the granitic mass and its variations belong to one igneous cycle of intrusion.

More Basic Phases

As mentioned, the amount of biotite in the quartz monzonite is consistently 5 per cent. Only slides 4678, 4715, 4766 and 4736 show a higher relative abundance than this, and approach 10 per cent. In these slides biotite is usually intimately associated with approximately equal proportions of hornblende. In some slides hornblende is the dominant ferromagnesian mineral, to the exclusion of biotite and quartz, and in extreme cases may represent as much as 25 to 40 per cent, and therefore approach a dioritic composition. It is thought that this later dioritic type gave rise to the development of the diorite porphyry apophyses, possibly as a result of some filter-press action operating on a zone of extreme contamination, and which is a localized zone in the quartz monzonite magma resulting probably from the assimilation of some sedimentary rock types.

The normal green amphibole is the predominant ferromagnesian mineral in 4668, 4669, 4691, 4693, 4695, 4708 and 4684, which are rocks from zones of contamination in the quartz monzonite. In 4713 hornblende contains biotite inclusions. Tremolite occurs in a few cases as plumose groups (4703 and 4694).

Diorite Porphyry

Diorite porphyry apophyses, sills and dykes occur within the granitic mass and penetrate the country rocks up to 75 feet from the contact zone. As mentioned above it is thought that they result from the injection of more basic phases of granitic magma. They cut the aplite dykes, and therefore they are slightly younger than the quartz monzonite massif and aplite dykes.

At 910,180-602,250 a diorite porphyry dyke intrudes a central portion of the quartz monzonite batholith . It is 20 feet wide and at least 150 feet long. A similar dyke at 903,330-610,850 intrudes the marginal zone of the batholith, and during its injection it plucked off rock fragments from its confining walls of country rock. Some xenoliths still have sharp margins; in others the margins are diffuse, and they are represented by concentrations of ferromagnesian minerals.

The diorite porphyry is a dark basic rock, showing light phenocrysts of felspar and long facets of hornblende laths.

Slides 4682 and 4717 are porphyritic with phenocrysts of plagioclase and hornblende (4717). Euhedral phenocrysts are corroded and in 4717 some myrmekitic texture is present. Plagioclase is more basic than that in the quartz monzonite and usually approaches labradorite in composition. Zonal bands in phenocrysts of 4682 alternate in composition. Felspar constitutes between 40 and 50 per cent of each slide.

Hornblende is the only ferromagnesian mineral, and alteration to epidote is common. In 4682 indistinct diopsidic cores contain alteration rims of tremolitic amphibole. Relative abundance of ferromagnesian minerals is between 25 and 50 per cent.

Quartz, when present, may occur as insignificant interstitial grains. Small quantities of magnetite occur in 4698 and 4682.

The rocks are diorites, or a late intrusive derived from a specialized basic phase of the original granitic magma, forming apophyses to the main granitic mass.

The Relation of the Quartz Monzonite to the St. Marys Porphyrite

At first appearance the quartz monzonite porphyry, which generally occurs marginal to the quartz monzonite mass (892,775-605,900), appears to have close textural similarities to the St. Marys Porphyrite. It differs in the type and proportion of ferromagnesian minerals present and it also contains numerous potash felspar phenocrysts.

Twelvetrees (1911) noted that hypersthene phenocrysts are abundantly developed in marginal zones of the quartz monzonite, and quoted the Beulah mine occurrence as an example (Tas. Mines Department Slide No. 224, A1Q15). Probably for this reason he considers the St. Marys Porphyrite a "border facies of the normal granitite", that is, Coastal Range quartz monzonite porphyry at the Beulah Mine. In the sections examined from Beulah mine area by the present writer, no hypersthene was seen (4766, 4733 and 4736). Hypersthene has not been observed associated with any phase of the granitic rocks, and the ferromagnesian minerals present are always biotite and hornblende.

In this paper, therefore, the St. Marys Porphyrite is considered a later mass distinct from the quartz monzonite massif, and is dealt with separately below.

Late Quartz Dolerite Dykes

Long, narrow basic dykes cut the Scamander succession in the vicinity of the quartz monzonite intrusive. The occurrence on the coast at 903,650-611,050 intrudes both the quartz monzonite and the country rocks. A 25 foot dyke at the Great Pyramid Copper Mine occurs in the country rocks (4762), and the occurrence at 898,600-603,600 is an intrusive of the same rock type (4716).

The dolerite is a fine dark-grey rock sprinkled with glistening facets of pyroxene and laths of felspar, and pyrite grains are scattered throughout. In section the rock has uniform texture and mineral composition. The fabric is intergranular to sub-ophitic. Small anhedral grains of pyroxene are badly fractured and have a grain size averaging about 1 mm. It is a light-green non-pleochroic clino-variety, of which some grains show alteration to fibrous amphibole. It constitutes about 50 per cent of each slide.

Plagioclase is seen as laths of about 2 mm. in length, which are invariably too altered to determine their composition. It shows twinning according to the albite law and has maximum extinction angle of about 15° (4762). Since the plagioclase grains have a low relief its composition approaches albite. Its relative abundance is 40 per cent.

Pyrite predominates among the remaining minerals and occurs as small and irregular grains abundantly scattered throughout the slide. It constitutes 15 per cent of slide 4762, but in 4761 there is only 5 per cent. Some magnetite is present. Quartz is relatively abundant, about 10 per cent occurring in groups of intergranular grains of 0·2 mm. size. Numerous fine apatite splinters, and grains of biotite and sphene, are frequently present. Biotite shows iron staining.

Alteration of the primary minerals is marked. Both amphibole and biotite are derived from the alteration of the pyroxene, and fibrous amphibole is associated with radiating clusters of chlorite. Up to 15 per cent of the slides may be tremolite and perhaps 5 per cent may be epidote and calcite, formed at the expense of original basic plagioclase in the development of albite. In all, accessory minerals and alteration products constitute about 30 per cent of the slides.

These altered quartz dolerites can be compared with altered dolerites at Hartley, New South Wales, described by Joplin (1937).

The slides show that the dyke rock is an altered quartz dolerite type preserving its original texture, although it lacks true ophitic fabric. It has undergone mainly low grade thermal metamorphism and associated stress effects are minor. The abundance of iron ore, quartz and well distributed apatite are unusual features.

The dyke rock was intruded after the emplacement of the granitic rocks, and probably represents the final igneous activity. It was possibly in the later stages of granitic consolidation that cooling of the doleritic magma underwent such autometamorphic and deuteric changes.

The St. Marys Porphyrite

The St. Marys Porphyrite was described by W. N. Benson for Twelvetrees' (1911) report on the Scamander area. He referred to it as a granitite porphyry of the St. Marys Pass. Subsequent more detailed work has shown that it is probably a porphyrite, under which heading it is now described, though it may be a dacite, as is discussed later.

The St. Marys Porphyrite crops out in the southern-most part of the area, south of an east-west line through Falmouth. Thirteen square miles of this igneous mass occur within the area under review, and the remainder extends beyond the southern limit. Only three miles of contact between the St. Marys Porphyrite and the Scamander succession occurs within the area and this represents only one tenth of its circumference. The contact has not been examined outside the area.

Contact relationships and Their Significance

The contact exposed between 885,275-599,925 and 885,950-601,975 approximates to a contour around ridges and spurs along which it intersects with the present surface of erosion. This contact relationship indicates the igneous mass has a floor gently sloping southwards at about 15 degrees.

The transgressive contact between the porphyrite and the adjacent sediments cuts straight across the ridge between 886,000-610,250 and 886,000-601,475. This apparent plunging discordant contact is similar to that of a granitic batholith. The projection of this transgressive contact line in a westerly direction is seen to intersect distinct physiographic depressions in other north-trending spurs. If the porphyrite has a floor these spurs should be capped with porphyrite, but those intersected by the contact contain no such capping. This suggests that a fault may be responsible for the transgressive nature of the contact.

Transgressive relationships are of limited occurrence and, in general, contacts indicate that the intrusion has a floor of Scamander Slate and Quartzite. The porphyrite was emplaced as an intrusive sheet or flow after regional folding of the Scamander succession and has not been subsequently folded.

No Scamander sediments were seen between the porphyrite and the overlying Permian sediments, nor were they seen exposed as inliers within the porphyrite. Contacts on Rays Hill and St. Patricks Head are between Jurassic dolerite and St. Marys Porphyrite. Hence, if the porphyrite is a sheet intrusive, it was uncovered before Permian time and the Permian sediments were deposited directly on top. They have since remained roughly horizontal. and if the porphyrite proves to be a dacitic flow, tilting occurred before the Permian sedimentation.

Estimated Thickness of the Porphyrite

Because there is no evidence of compound or multiple emplacements, there are certain upper limits of thickness beyond which the existence of a simple viscous flow would be exceptional Consideration must therefore be given to the thickness of the igneous mass, for this may be diagnostic in identifying the igneous forms on physical grounds. If the porphyrite is an intrusive sheet its thickness would be governed by the capacity of the Scamander sediments to accommodate the magma, an inestimable factor on present knowledge. The thickness would not significantly eliminate the possibility of its being a sheet, as it would if it is a flow.

Estimation of thickness can only be established approximately. There is at least 1500 feet difference in altitude between the floor of the mass at German Town and that at Falmouth. If three major faults of the north-west system progressively down-stepped the igneous mass towards the coast, then east flowing streams could deeply dissect a relatively thin igneous mass without exposing the underlying Scamander Slate and Quartzite.

In the south-west corner of the area around German Town, the difference in altitude of the floor contact and the highest outcrop of the igneous mass, provided no fault intervenes between the two, would give another rough estimation of minimum thickness.

From the above estimations it is probable that, if the porphyrite was a flow, it would be a single dacitic outpouring at least 500 feet thick.

Other Field Observations

Joints are more pronounced in the contact zone, where, usually, a series of parallel breaks has developed in the porphyrite. At 885,950-601,975 jointing planes strike 155° at 32°SW. Central regions of the porphyrite show mural jointing more characteristic of a granitic outcrop.

Xenoliths occur throughout the igneous mass, but only the larger ones remain in coastal zones. The coastal exposure at 884,525-600,225 shows abundant xenoliths in the porphyrite. Small inclusions of slate and quartzite fragments from the Scamander succession were incorporated into the magma. These can be recognized in marginal zones, but often as a result of their advanced stage of assimilation they commonly become chloritic clots in the central zones.

No apophyses were seen associated with the porphyrite, and no mineralization accompanied its emplacement.

Petrography

The porphyrite is a blue-grey rock with porphyritic texture, containing phenocrysts of quartz, felspar, pyroxene, biotite and sparse hornblende. It appears to be remarkably homogeneous in both texture and in mineralogy. Grain size varies systematically throughout the mass, ranging from porphyritic in the marginal zones to medium even-grained in the more central portions. Quartz and felspar phenocrysts measure up to 5 mm. in size and ferromagnesian minerals, including hypersthene, have a maximum grain size of 2 mm. Sometimes euhedral phenocrysts of plagioclase and quartz occur, but more commonly they are sharply angular fragments derived from shattered phenocrysts more characteristic of a pyroclastic rock. Hence, in many cases the texture of the rock is typically volcanic. Corrosion and pseudo-inclusions are common, particularly in quartz and felspar phenocrysts. This is especially noticeable near the margins of the igneous mass, but it is also a feature of more central zones where much hypersthene is altered to amphibole. In some cases the groundmass has penetrated along cleavage planes of biotite, forcing biotite flakes apart and causing them to flex.

In the slides of marginal rocks 4670, 4654 and 4657 flow structure on a microscopic scale occurs around partly assimilated argillaceous rock fragments. This structure is not apparent in field exposures. Marginal slides contain hypidiomorphic phenocrysts in a crypto-crystalline groundmass. In the central portions the groundmass consists of fine interlocking grains of quartz and felspar, and the fabric appears to be somewhat metamorphic, probably because consolidation was slower than in the contact portions.

In 4652, grains adjacent to fractures show signs of strain. Invariably the cryptocrystalline groundmass in the contact zone is fractured by numerous irregular cracks, which probably result from strains set up in the process of consolidation.

In the central zones small grains of quartz are included in felspar phenocrysts. Felspar is often zoned, and these zones alternate with little compositional difference between them and do not show gradational changes from basic to more acid towards the margin. The composition of plagioclase approaches labradorite Ab_{45}, An_{55}, and phenocrysts constitute about 27 per cent of the rock. Twin lamellae are invariably ruptured.

Staining tests (Chayes, 1952) did not reveal the presence of any potash felspar, though some may be occluded within the fine groundmass.

Quartz is relatively abundant as colourless euhedral grains and angular fragments and is invariably badly cracked. The average grain size is a little larger than plagioclase and it forms 26 per cent of the rock.

Biotite is moulded around hypersthene crystals or is intimately associated with magnetite grains. It develops in cracks which probably result from stresses associated with the emplacement of the magma. It is slightly more abundant than hypersthene and constitutes approximately 5 per cent of the rock.

Hypersthene is present in both marginal and central zones, as prismatic and euhedral crystals up to 2·5 mm. in size. Most grains are cracked, and have reaction rims of amphibole, with similar alteration along the cracks in grains. Some grains are enveloped by plagioclase.

Magnetite and a little apatite occur as accessory minerals, and numerous inclusions of clinozoisite within the felspar grains result from its alteration. The groundmass forms about 37 per cent of the slides, and consists, where it can be resolved, of quartz and untwinned felspar.

Form of Emplacement of the Porphyrite

From the above petrological evidence there seems little doubt that the porphyrite magma was partly crystallized at depth before it was emplaced in higher levels of the earth's crust. An intratelluric origin for the phenocrysts present is shown by a number of features. The fractured and fragmentary nature of many phenocrysts, especially felspar and quartz, accompanied by ruptured twin lamellae and bent biotite flakes, are all indicative of strains imposed on these mineral grains during the process of magma emplacement. The immunity of some fractures in mineral grains to corrosion by the liquid groundmass suggests that these fractures were formed at a late stage of consolidation.

The metastable state of the magma after emplacement in the near surface environment is shown by the corroded nature of felspar and quartz phenocrysts. Rapid cooling forestalled chemical readjustment and also sealed other evidence before significant changes could occur. Consequently, in the contact zones microscopic flow structure and cryptocrystalline groundmass can be seen, as well as the somewhat metastable mineral assemblage.

Contact alteration induced by the porphyrite in the adjacent Scamander Slate and Quartzite, discussed previously, was very slight or negligible. This feature accompanying such a large magmatic emplacement strongly suggests a rapidly cooling contact surface, as would be expected between a flow and its basement rocks.

The mineral assemblage of quartz, labradorite and hypersthene is not uncommon in andesitic flow rocks. The magma seems to have been extremely homogeneous. The abundance of quartz is exceptional and indicates that the composition is dacitic rather than that of a quartz-hypersthene andesite. Another feature is the absence of potash felspar.

It is difficult under the circumstances to name the rock precisely. The igneous form of the porphyrite has not been conclusively established yet, but present indications are that it has a floor. Microscopical examination strongly supports a flow origin for the rock and, if so, it is dacitic; but present field evidence is insufficient to prove this. Hence, if it is a near-surface discordant sheet, it could be referred to as a quartz-hypersthene porphyrite.

The Age of Igneous Rocks—Discussion

The granitic rocks and the St. Marys Porphyrite cannot be accurately dated: they are unquestionably Palaeozoic, and probably either mid-Devonian or lower Carboniferous. This conclusion is reached by comparison with similar occurrences in other parts of the State and Eastern Australia, especially Victoria, and by the fact that the quartz monzonite intrudes sediments considered, on their poor fossil remains, to be of upper Silurian or lower Devonian age. The leucocratic granite phase of St. Helens Point—aplite and diorite porphyry intrusives—although slightly younger than the quartz monzonite, are co-magmatic. The post-granite quartz dolerite dykes probably represent the last phase of this igneous cycle. They may have been intruded during the later stages of consolidation of the main granitic massif.

The diagnostic differences between Tabberabberan and Kanimblan acid intrusives of Eastern Australia are outlined by David (1950). The Devonian or Tabberabberan granitic rocks are considered to be adamellites introducing very little mineralization, perhaps some copper, lead and silver. They were preceded by co-magmatic porphyries and porphyrites, a few of which contain hypersthene. The intrusions were biotite and hornblende granitic rocks of a subsequent type, but so were the Kanimblan granites.

In north-east Tasmania present evidence strongly suggests that the St. Marys Porphyrite follows granitic emplacement with perhaps an interlude of erosion after the folding of the Scamander Slate and Quartzite. It was definitely emplaced before Permian sedimentation. The granitic intrusion was a subsequent type containing biotite as the ferro-magnesian mineral. The Coastal Range quartz monzonite contains restricted zones of marginal porphyry without hypersthene. It introduced tin, tungsten, bismuth, molybdenum, copper, gold, silver and lead.

The possibility of two ages of granitic emplacement in the area cannot be completely overlooked, and indeed, Thomas (1943) believes this to be so. He considers that the tin granite is a separate intrusive; but present field and petrological work provisionally indicates that the granitic rocks belong to one intrusive cycle and the different leucocratic and contaminated intrusive phases which accompany the quartz monzonite intrusive are comagmatic.

Similar granitic activity in other parts of the State is considered mid-Devonian (Hills and Carey, 1949), and on the argument of uniformity, the granitic occurrence in north-east Tasmania could be considered of the same age. This means that the St. Marys Porphyrite was probably emplaced at a time slightly later than middle Devonian.

Dolerite of the Mt. Nicholas Sill

Tholeiitic dolerite occurs in the south-west corner of the area constituting the greater part of Rays Hill at German Town. It intruded the consolidated Permian sediments as dykes and sills in the Jurassic time, resting with discordant relations on the St. Marys Porphyrite and the Scamander Slate and Quartzite. Sills of dolerite occur both at the top and at the base of the Permian succession.

The texture of the rocks is ophitic and intersertal with porphyritic texture in the contact zones showing phenocrysts of enstatite and pigeonite (4648). A little interstitial quartz and alkali felspar in micrographic intergrowth forms part of the mesostasis.

Plagioclase occurs mainly as fine laths, but occasional stout prisms are seen, and grain size grades up to 0·25 mm. Twinning according to both the albite and Carlsbad laws indicates the composition ranges from andesine Ab_{55} An_{45} to labradorite Ab_{40} An_{60}, and in zoned crystals the outer zone is the more calcic variety. Zoning is poor, but as many as three zones have been seen, each differing in composition from the next innermost zone by about 10 per cent anorthite. In 4648 plagioclase constitutes about 50 per cent of the slide.

The average grain size of pyroxene is about 1 mm. Grains and prisms of pigeonite have been moulded on felspar laths, characteristic of ophitic textured rocks. Many enstatite phenocrysts have a reaction rim of clinopyroxene. Orthopyroxene appears to be restricted to the contact margin, but clinopyroxene occurs in all levels of the sill including the contact zone (slide 4648). The pyroxene makes up the remaining 50 per cent of the slides, since the proportion of minor constituents is very low.

Rock 4648 comes from the chilled margin at the contact with the St. Marys Porphyrite. In contact zones enstatite is the predominant pyroxene constituting 40 per cent of the slide, and has a 2 V of about 75°. The remaining pyroxene, pigeonite, has a 2 V between 0° and 30°. It characteristically shows herringbone structure, especially in the twinned crystals, and in the more central and coarser portions of the sill. It is the essential pyroxene. Bronzite occurs exclusively near the margins, hence this intermediate type was the first pyroxene to crystallize. Augite is also present in some slides, and therefore a fairly complete representation of the pyroxene solid solution series occurs within the sills. Augite grains are about 1 mm. size. Accessory minerals include biotite and iron ore.

The minor constituents quartz, alkali felspar, mica and amphibole are not seen in contact slides. Also, iron ore is scarce and grains are small in these slides, but become larger in more central zones. Quartz frequently occurs in higher portions of the sill as interstitial grains in the mesostasis, and occasional light to dark-brown grains of amphibole occur in zones other than the contact zones.

Secondary alteration of the pyroxene forms chlorite and a little associated iron ore. Chlorite is well developed as green fibrous growths in partings or as alteration rims to the pyroxene grains. Other secondary minerals include amphibole and calcite.

These features are in keeping with a tholeiitic dolerite magma homogeneous in texture and composition. As indicated by Edwards (1942), the magma was essentially liquid at the time of intrusion, although crystallization had begun, as is shown by the phenocrysts of orthopyroxene in the fine groundmass of the chilled margin (4648). In the Mt. Nicholas sill crystallization was slightly more advanced before intrusion than it was in many other similar sills in the State, and Edwards (1942) has shown that phenocrysts of the enstatite are larger and more abundant than in other localities, and that the rock shows a higher MgO content.

Contact metamorphism in the immediate contact sediments resulted only in minor localized changes.

STRUCTURE

Structural considerations must necessarily be conjectural owing to the present restricted knowledge on the stratigraphy of the Scamander Slate and Quartzite. The paucity of suitable exposures for structural and stratigrapical analyses leaves the structure obscure. Its complexity is no doubt accentuated by the frequency of minor breaks, and the monotonous regularity of the sedimentary succession in lithology and strike measurements. The location of major and minor faults proves difficult for the reasons mentioned, and in the absence of marker horizons determination of fault displacement is impossible.

The paucity of outcrop of Scamander Slate and Quartzite for structural analysis is due, on the one hand, to the masking effects of inherent short jointing in the stratified and indurated rock types, causing their outcrop to disintegrate, and shed rock debris concealing all structural features beneath it; and on the other hand, to the barren nature of massive quartzite outcrops. Only stratified coastal and road cuttings are available for structural measurement.

The initial structural and stratigraphic analysis of the Scamander Slate and Quartzite will have to be resolved outside the area under review and then extrapolated to this area.

Jointing

Regular jointing is a prominent feature. Not only does it characterize the brittle zone of deformation, where it is pronounced, but it is superimposed also on the plastically moulded rocks adjacent to the quartz monzonite.

Joints in a particular locality differ slightly in direction and these variations probably reflect slight changes in the physical properties of the rock types. In general, joint directions are consistent.

Analysis of jointing in the coastal exposure one mile north of Diana Basin (903,490-610,880 to 903,650-611,050) suggests that it belongs to one system. Fracture has occurred in three directions, including that parallel to the bedding. These are (1) 190° (2) 245° and (3) 305°. A number of other minor directions of failure developed, probably in sympathy with the major breaks.

Slight lateral displacement has occurred along some joint directions, particularly along 205°. Such breaks displace aplitic veins and apophyses from the adjacent granitic intrusive. Other joint directions may be older than these post-granitic breaks, since parallel folding of thinly bedded strata in the brittle zone would result in tension cracks developing in crests and troughs of folds.

Epeirogenic movements in the lower Tertiary probably imposed some jointing on the rocks of the area, and undoubtedly the Permian was jointed as a result of this gravitational readjustment. The relationship of jointing in the Scamander succession to that in the Permian rocks could not be established, but it is apparent that the intensity of jointing in the Scamander Slate and Quartzite is far greater.

Folding

The oldest structural features were developed when the Scamander succession was regionally folded and then injected by a granitic magma. In the contact zone the sediments were moulded into intricate folds and contortions, and evidently reached a sufficiently high temperature to be deformed plastically into similar type folds. A localized occurrence of this type of folding can be seen in the coastal outcrop one mile north of Diana's Basin. Away from the immediate contact zone folding is close, but broadens rapidly in more remote areas. Deformation in this brittle zone has resulted in parallel type folds (Hills, 1940) ruptured by numerous minor breaks, especially in the fold crests and troughs.

Along the coastal outcrop mentioned above, the closely parallel folded strata are steeply dipping and have a regular strike of 125°. In the Upper Scamander road sections (891,550-604,050 and 891,650-604,000) moderate to steeply dipping Scamander Slate and Quartzite show broader parallel folds and strike between 10° and 20°. Dips change systematically from 15° to 50°W, and a few openly folded anticlinal structures can be recognized. The crests of most folds have been eroded, so that few complete folds were seen in this area.

This consistent westerly dip suggests either that folds are repeatedly overturned from the west or that there may be many repetitions due to folding and faulting. The only easterly dip recorded was in the Scamander quarry where the strata dip at 60°. The possibility that anticlinorial and synclinorial structures are developed in the area seems doubtful.

Faulting

Faulting in the lower Tertiary affected the whole area. The extent of this faulting is demonstrated by the down faulting of a small residual of Permian at (884,250-603,550), mentioned previously. This outlier of Permian in the Falmouth area has been downthrown relative to its equivalent stratigraphical horizon at German Town by a series of north-west-trending faults progressively down stepping it eastwards, resulting in a cumulative vertical displacement of 1300 feet. Faulting is not pronounced along the St. Marys Porphyrite contact from 885,275-599,925 to 886,000-601,250, but from 886,000-601,250 to Falmouth all north-east trending valleys are fault valleys.

There is a number of difficulties in analysing the lower Tertiary fault system. As mentioned, topography is controlled to a certain degree by faulting, and this helps in defining linears on the aerial photographs, but only those that cut igneous contact zones can be recognized in the field. Hence the present representation of faults and trends on the map is misleading, for the density of the faults is greater in these contact zones. Those occurring completely within the Scamander Slate and Quartzite, or within the granitic rocks, may be just as dense, but are hidden. Faults which have been mapped are plotted with vertical displacement, lacking evidence to the contrary. Faults in the Orieco copper workings all dip at high angles, averaging 80° SW. Analysis of the faults mapped and inferred from photo-interpretation indicates that two directions of failure are favoured, and both belong to the same fault system.

In the fault system of the southern part of the area, fault trends in St. Marys Porphyrite occur in two directions: (*a*) N.W. (*b*) N.E.

In the eastern and north-eastern regions of the area similar trending faults cut the Coastal Range quartz monzonite and the marginal zones with the adjacent sediments:

(*a*) N.W. (*b*) N.E.

In the western zone, which consists essentially of Scamander Slate and Quartzite, Henderson (1941) records faults of an older system which trend 315° and this direction includes the mineralized channels of the Ringarooma P.A., Orieco and Dunn's prospects. He says that shafts of the Orieco appear to be located on a prominent cross fault, while a second group of faults strikes 190° and dips 70°E, and the remaining faults are at 280°, but are not very extensive in this direction.

Other Structural Events

If the St. Marys Porphyrite proves to be a flow, then the possibility that it has been tilted before Permian sedimentation must be recognized, and it would be expected that jointing of the adjacent country rocks would result from this. There is no other apparent structural evidence in the area to suggest this fault block tilting took place.

In the south-west corner of the area, the structure of the Permian succession has been controlled by the intrusion of dolerite and concomitant faulting. The upwelling magma rotated and differentially displaced Permian sedimentary blocks relative to one another. The Permian beds dip at low angles, 0 to 5°, probably owing to a combination of depositional dips and tilting in the dolerite magma. Jointing is pronounced in places, and this results, as mentioned above, from the Tertiary faulting.

ECONOMIC GEOLOGY

Mineralization in the area resulted in the introduction of molybdenum, bismuth, tin, tungsten, copper, silver, gold and lead. After the emplacement of the granitic rocks, possibly the first joint direction to develop after its consolidation was that favoured by the mineralizing solutions for ore deposition.

The biotite-quartz monzonite is the predominant granitic rock of the area. It is intruded by minor quantities of a slightly later phase muscovite granite. Exactly which intrusive brought in tin is not known. Thomas (1943) suggests that two granitic intrusives exist, one of which is tin-bearing.

Primary Tin-Tungsten

The general axis of tin-tungsten mineralization is roughly north-south. This line of primary mineralization persists from 905,150-600,940 through to the Upper Scamander tungsten deposits, two miles west of the Pyramid. Henderson (1941) says that structural relations indicate a regional break in which the east block moved north along this line.

Most probably the greater part of the wolframite has been removed by erosion; and granitic rocks are either close to, or actually exposed at, the surface. Consequently only minor quantities of high temperature mineralization remain, and the original deposits are now represented by secondary alluvial deposits.

The presence of copper in the Orieco workings, although mainly secondary, perhaps indicates that here a rather thicker sedimentary cover exists on the granitic rocks.

The primary tin-tungsten deposits occur as veins in the granitic rocks.

On Constable Creek (905,150-600,940) tungsten mineralization may occur in the hood of a cupola or an exposed high of the granitic intrusive. A little crystallized cassiterite also occurs in the joint planes of the adjacent quartzites. These sediments strike approximately north-west and the granitic rock is jointed in the 45° and 105° directions. About 40 mineral veins occur and they all strike 285°.

In 1952 the main lode had been opened up a distance of 500 feet and in places proved to be 25 feet deep. The veins bulge and pinch along their length and in the main vein the width varies from less than a foot to six feet in one place. The other veins are mineralized to differing degrees, but are of minor size in comparison with the main one. Minerals present include wolframite, scheelite, molybdenite and bismuthinite in a gangue of quartz, arsenopyrite and pyrite.

Up to 1952 one ton of wolframite had been extracted from the main vein. The deposit averaged approximately one per cent; the wolframite occurs generally in small isolated concentrations, intimately associated with molybdenite in the gangue of essentially quartz. The hanging and foot walls are of hydrothermally altered aplitic material, a quartz muscovite rock.

Alluvial Tin

Most of the tin ore from north-east Tasmania has been won from alluvial deposits which occur as leads along comparatively well defined courses. The main group of tin fields occurs a little to the north-west of the area under review.

Tin is worked on different levels of lead development, mainly superficial ones overlying Thureau's Lead, subsidiary leads, or along the present day streams in the vicinity of Thureau's Lead. Some tin is worked from decomposed granite *in situ*.

Deposits range up to 20 feet in thickness, but usually average between 5 and 12 feet of probable fluvial deposits consisting of clays, sands, gravels and unconsolidated ferruginous and argillaceous quartz granule conglomerates.

The bottom is sometimes decomposed granite, as mentioned, but generally it is clay or gravel with the lead, in which case it is locally referred to as "marine bottom".

Throughout the gravel profile there are definite horizons in which tin is concentrated, while the remainder is barren or uneconomical.

Tin in the cassiterite assays as high as 75·4 per cent and 1 to 1·5 per cent tungsten is associated with it in some pockets. Other minerals present, according to Nye (1933), are ilmenite, pleonaste, zircon and sapphire, &c.

The source of the tin is unknown at present, but some at least would be derived from the decomposed granite containing disseminated tin. The remainder would come from vein tin of unknown location, and conditions governing concentration have been discussed.

Copper

The copper deposits lie about two miles north, north-east of the Upper Scamander Bridge. The Orieco lode runs north-west for two miles from the western bank of the north arm of the Scamander River.

The occurrence consists of groups of parallel arsenopyrite — quartz-chalcopyrite veins with occasional development of zones of mineralized material on each side of the primary fissure. The veins occur in fissures of great length, along which differential movement is not extensive. The shoots of ore appear to pitch in a southerly direction.

The copper minerals have been leached to a depth of 200 feet, and the oxidized ores include cuprite, chalcanthite, azurite and malachite.

Henderson (1941) states that the chief concentrations of secondary ore occur as selvages on a wide formation of much kaolinized slaty lode material, and that mineralization appears to be confined to crush zones, particularly in the thinly bedded slates, and follows the many component fractures of the zone.

The structure of the west fault block is essentially an overturned south pitching fold, the truncated crest of which is composed of dense blocky sandstone and quartzites with occasional intercalations of thinly bedded slates. Few crush zones are developed on the eastern side of the main ore channel where thinly bedded slates are more apparent. Many crush zones occur in essentially blocky sandstones or quartzites, but no mineralization is associated with them.

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LOCALITY INDEX

	Quadrangle	S. Lat.	E. Long.
Coastal Range	St. Helens 41	41° 22′	148° 20′
Diana Basin (Inlet)	St. Helens 41	41° 23′	148° 18′
Falmouth	St. Marys 49	41° 29′	148° 16′
George Bay	St. Helens 41	41° 19′	148° 18′
German Town	St. Marys 49	41° 32′	148° 17′
Goshen	St. Helens 41	41° 17′	148° 6′
Hendersons Lagoon	St. Helens 41	41° 29′	148° 16′
Meadeas Cove	St. Helens 41	41° 20′	148° 14′
Moriarty Lagoon	St. Helens 41	41° 18′	148° 20′
Mount Nicholas	St. Marys 49	41° 32′	148° 12′
Paddy's Island	St. Helens 41	41° 24′	148° 19′
St. Helens	St. Helens 41	41° 18′	148° 14′
St. Helens Point	St. Helens 41	41° 17′	148° 22′
St. Helens Island	St. Helens 41	41° 21′	148° 20′
St. Marys Pass	St. Marys 49	41° 35′	148° 17′
St. Patricks Head	St. Marys 49	41° 34′	148° 19′
Scamander	St. Helens 41	41° 27′	148° 21′
Upper Scamander	St. Helens 41	41° 27′	148° 13′
Wrinkler's Basin	St. Helens 41	41° 27′	148° 20′

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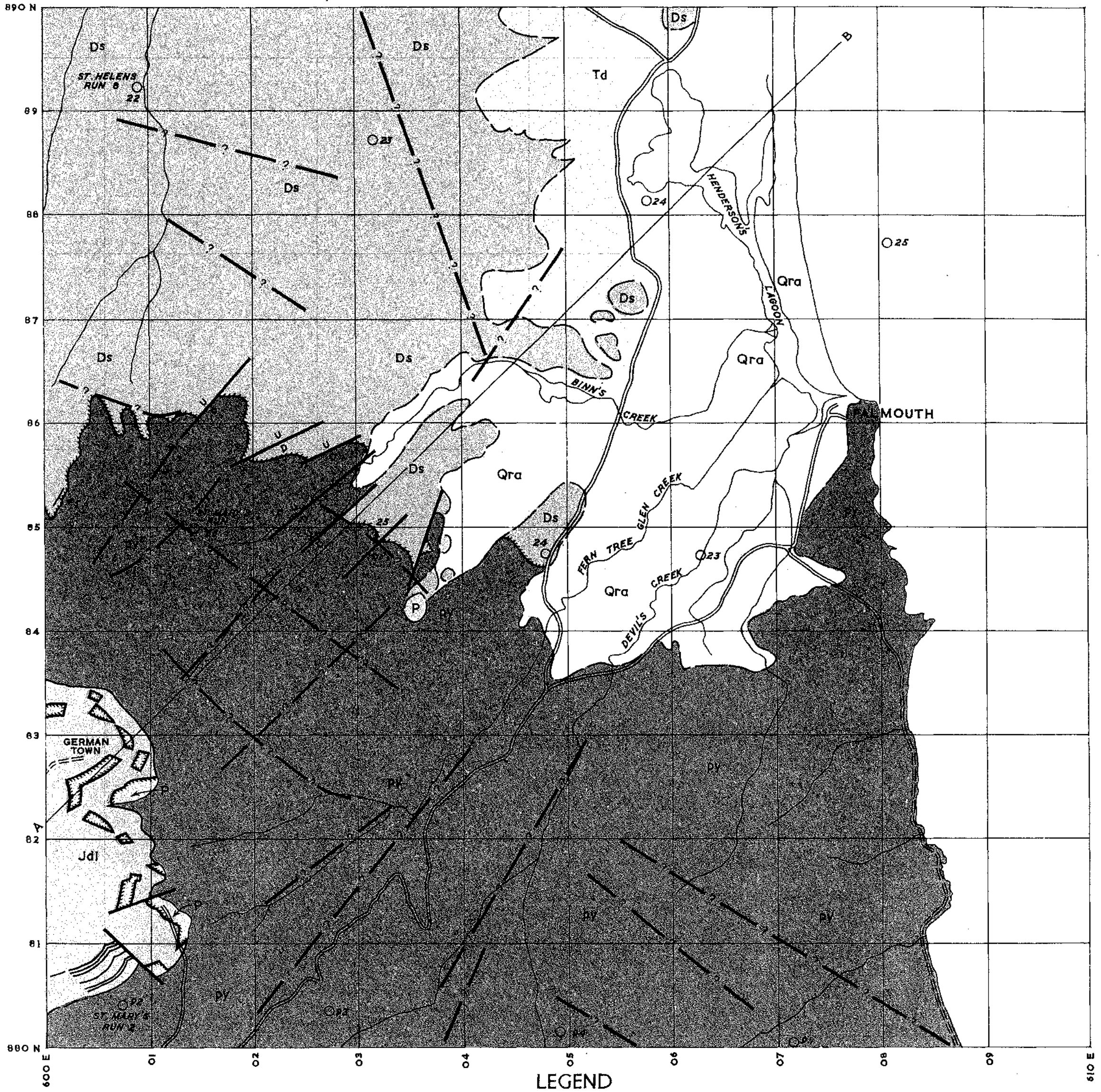
FALMOUTH

6088



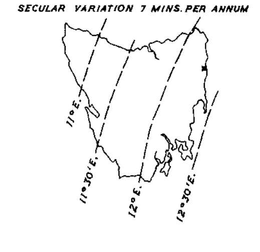
LEGEND

- FAULT WITH DOWNTHROWN SIDE INDICATED
- PHOTO-INTERPRETED FAULT
- ESTABLISHED BOUNDARY — POSITION ACCURATE
- ESTABLISHED BOUNDARY — POSITION APPROXIMATE
- DISCORDANT INTRUSIVE BOUNDARIES
- DISCORDANT INTRUSIVE BOUNDARY WITH CONCOMITANT FAULTING
- 45° STRIKE AND DIP
- ROADS
- VEHICULAR TRACK
- TRACK
- PHOTO CENTRE

Quaternary System
RECENT SERIES
Qra ALLUVIUM
Tertiary System
Td DIANA'S BASIN SANDS AND GRAVELS
Permian System
P
Mathinna Group
Ds SCAMANDER SLATE AND QUARTZITE

IGNEOUS ROCKS
Jdl JURASSIC DOLERITE
Py ST. MARY'S PORPHYRY
Dc COASTAL RANGE QUARTZ MONZONITE

Compilation from Aerial Photographs. Trigonometric Station Control by courtesy Lands and Surveys Dept. Origin of co-ordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7.

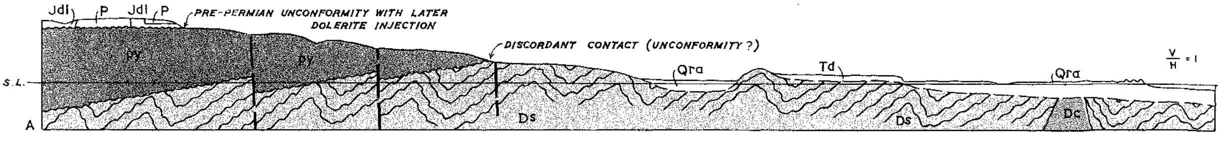


— SCALE —

0 1 2 MILES

0 1 2 3 4 5,000 10,000 FEET

MAPPED AND COMPILED BY
K. R. WALKER 1953



GEOLOGY OF FALMOUTH

SHEET 6088

PHYSIOGRAPHY.

Two physiographic units occur in this area, a low, mountainous, early mature hinterland and a partially rejuvenated, youthful coastal plain. Drainage more or less radiates from the area around German Town and St. Patrick's Head. The streams are in mountain tract for about half their course and then enter valley tract in which they remain till they reach the sea. In the Scamander Slate and Quartzite the joints control the streams and in the St. Marys Porphyry streams are controlled by faults. The coastal plain ranges from 350 feet above sea level inland to 170 feet towards the coast. This plain is deeply dissected but the hills still carry a cover of sediment and hill levels are accordant. Still closer to the coast are the barred lakes, lagoons and swamps behind the beach ridges and beaches. South of Falmouth the coast is cliffed but to the north it is mainly long beaches, and the coast is comparatively straight. The Scamander River is considered to have originally flowed into the sea near Falmouth.

STRATIGRAPHY AND IGNEOUS ROCKS.

The basement rock in the area is the Scamander Slate and Quartzite. This formation is of unknown thickness and contains argillites and arenites of the sub-greywacke suite. North of the area it contains primitive vascular plants and fragmental marine fossils. It may be in part Silurian or Lower Devonian. The deposition of these beds was followed by folding, then intrusion of the Coastal Range Quartz Monzonite. Sometime later the St. Marys Porphyry was emplaced, perhaps as a lava flow. Tilting and erosion followed before deposition of the Permian sediments began. Several Permian formations are present and include a limestone and a glauconitic sandstone. Later, probably in the Jurassic Period, the Permian sediments were disrupted by dolerite intrusions.

Later faulting further disrupted the Permian and older rocks and after this the coastal plain and the sediments on it developed.

STRUCTURAL GEOLOGY.

The Scamander Formation is folded along axes trending N15°E to N20°E and generally somewhat overturned to the east. Where the base of the St. Marys Porphyry is exposed it is seen to be dipping 15° to the south. The Permian and Tertiary beds are virtually horizontal.

Faults affect the Scamander Formation, Coastal Range Monzonite, St. Marys Porphyry and the Permian sediments. These form a conjugate system, trending north-west and north-east. Some of these at least are post-Permian as the Enstone Park Limestone (Permian) occurs on Rays Hill and much lower topographically at Enstone Park. Faults associated with the intrusion of dolerite also affect the Permian beds near German Town.

POINTS OF SPECIAL INTEREST.

Permian Section on Rays Hill (600.5E.880.5N)

St. Marys Porphyry in St. Marys Pass (602.5E.880.5N)

Base of St. Marys Porphyry (602.2E.886N)

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SCAMANDER

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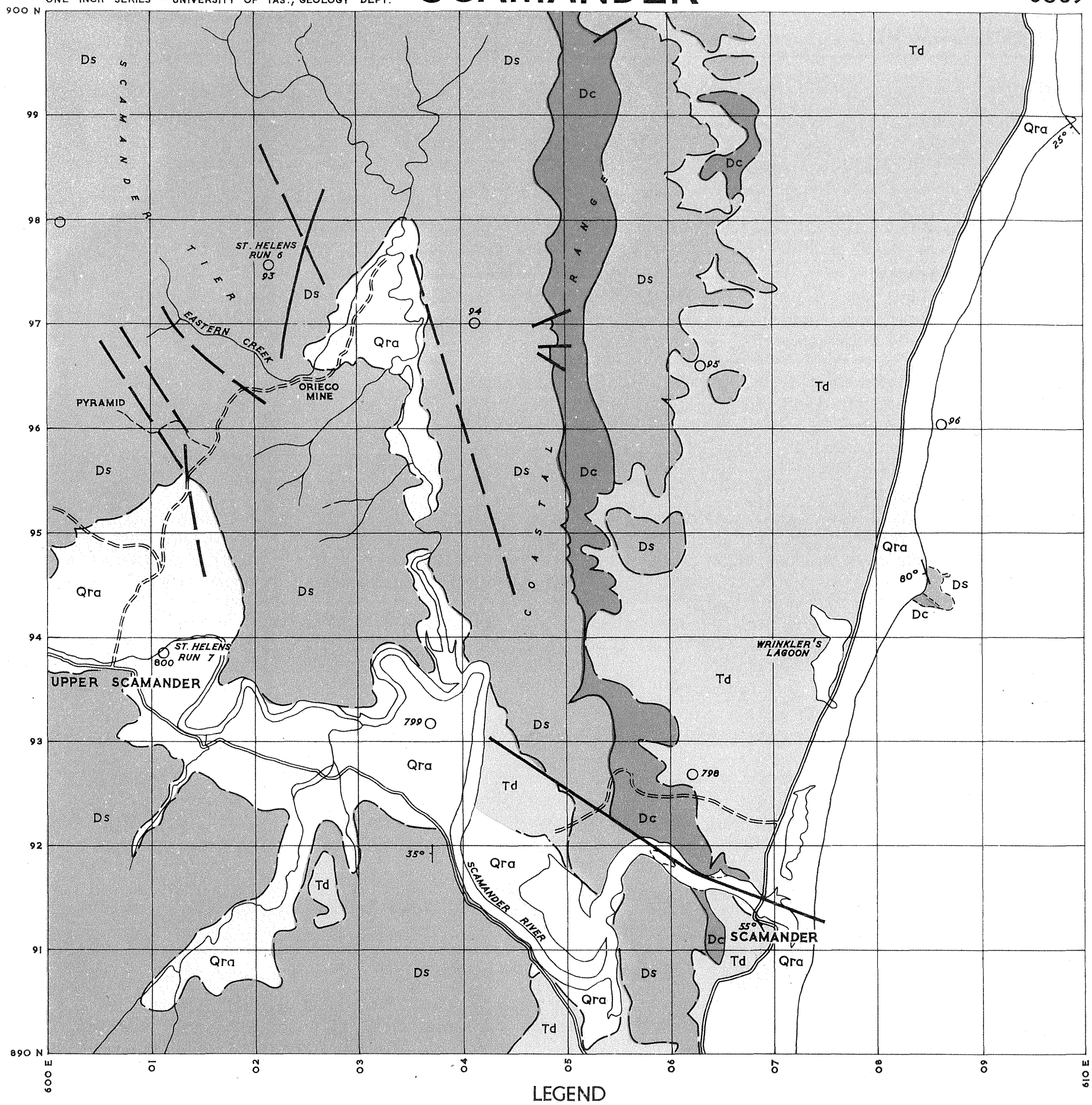


LEGEND

FAULT WITH DOWNTHROWN SIDE INDICATED (D / U)

PHOTO — INTERPRETED FAULT

ESTABLISHED BOUNDARY — POSITION ACCURATE

ESTABLISHED BOUNDARY — POSITION APPROXIMATE

55° STRIKE AND DIP

ROADS

VEHICULAR TRACK

TRACK

BRIDGE

PHOTO CENTRE

Quaternary System
RECENT SERIES

Qra ALLUVIUM

Tertiary System

Td DIANA'S BASIN SANDS AND GRAVELS

Mathinna Group

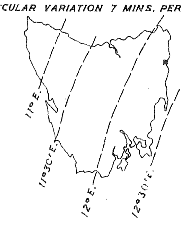
Ds SCAMANDER SLATE AND QUARTZITE

IGNEOUS ROCKS

Dc COASTAL RANGE QUARTZ MONZONITE

Compilation from Aerial Photographs. Trigonometric Station Control by courtesy Lands and Surveys Dept. Origin of co-ordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7.

KEY MAP SHOWING MAGNETIC DECLINATION SECULAR VARIATION 7 MINS. PER ANNUM



— SCALE —

0 — 1 — 2 MILES

0 1 2 3 4 5,000 10,000 FEET

MAPPED AND COMPILED BY
K. R. WALKER - 1953

GEOLOGY OF SCAMANDER.
SHEET 6089

PHYSIOGRAPHY.

There are three physiographic units in this area. The western-most one is characterised by Scamander Tier and the Coastal Range and is an area of late youthful or early mature topography drained dominantly by streams in their mountain tract. The exception to this is the Scamander River which is a drowned river in its valley tract. Further east still is the coastal plain with a veneer of gravels and sands up to a height of 350 feet. This is deeply dissected but still youthful. Near the coast this plain is succeeded by a strip of lagoons, swamps, marshes, beach ridges and long sweeping sandy beaches with occasional rocky headlands.

The western unit seems to have been part of an easterly dipping uplifted surface which locally reaches 1,500 feet high on Scamander Tier. Drainage in the western area has a trellised pattern, being controlled by bedding and prominent joints at right angles to it.

STRATIGRAPHY.

The oldest rock in the area is the Scamander Slate and Quartzite. This formation consists of slates, siltstones, quartzites, sandstones and sub-greywackes. Some banding is present. Depositional rolls, slump structures and cross-bedding occur. Fossils in this formation include primitive vascular plants and fragmental marine fossils.

The next formation is the Diana's Basin Sand and Gravel which caps the coastal plain. These reach a thickness of 150 feet and are up to 350 feet above sea level at which height a ferruginous granule conglomerate is common. No fossils have been found in the formation and it is regarded as Tertiary on physiographic grounds.

The youngest beds in the area are the dune and beach sands and river alluvium.

IGNEOUS ROCKS.

The Coastal Range Quartz Monzonite forms the axis of the Coastal Range where it intrudes the Scamander Slate and Quartzite with sharp contacts. Temperature of the intrusion was just enough to produce plastic deformation of the intruded rocks. The monzonite contains andesine, microcline, quartz, biotite and hornblende with some orthoclase, apatite, muscovite and other minerals in small amounts. Numerous textural variations occur; aplitic and pegmatitic veins occur associated with the main stock. Transgressing the quartz monzonite are dykes of diorite porphyry which also intrudes some of the aplites. The diorite porphyry consists essentially of labradorite and hornblende. Quartz dolerite dykes cut the Scamander Formation and the monzonite and may be late magmatic differentiates of the monzonite magma.

STRUCTURAL GEOLOGY.

The Scamander Formation is folded along axes trending N15°E to N20°E and usually overturned slightly to the east.

Faults with a north-easterly, easterly and south-easterly trend offset the monzonite contact but only by small amounts. A fault trending somewhat south of east displaces the contact of the monzonite, south side east, on the Scamander River and reduces the width of outcrop of the monzonite stock considerably suggesting a downthrow to the south.

ECONOMIC GEOLOGY.

The Pyramid, Orieco and Beulah Mines occur within this area. The Orieco deposit contains copper in the form of chalcopyrite in ore shoots in crush zones in thinly bedded slates. The Beulah Mine was worked unsuccessfully for silver. None of the mines is economically significant at present.

POINTS OF SPECIAL INTEREST.

Scamander Formation with fossils in cuttings on the Upper Scamander Road (604.000E.891.5N)

Scamander Formation marine fossils in quarry on south side of bridge over Scamander River (606.8E.891.6N).

Beulah Mine (606.3E.891.6N).

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GEOLOGY OF TASMANIA

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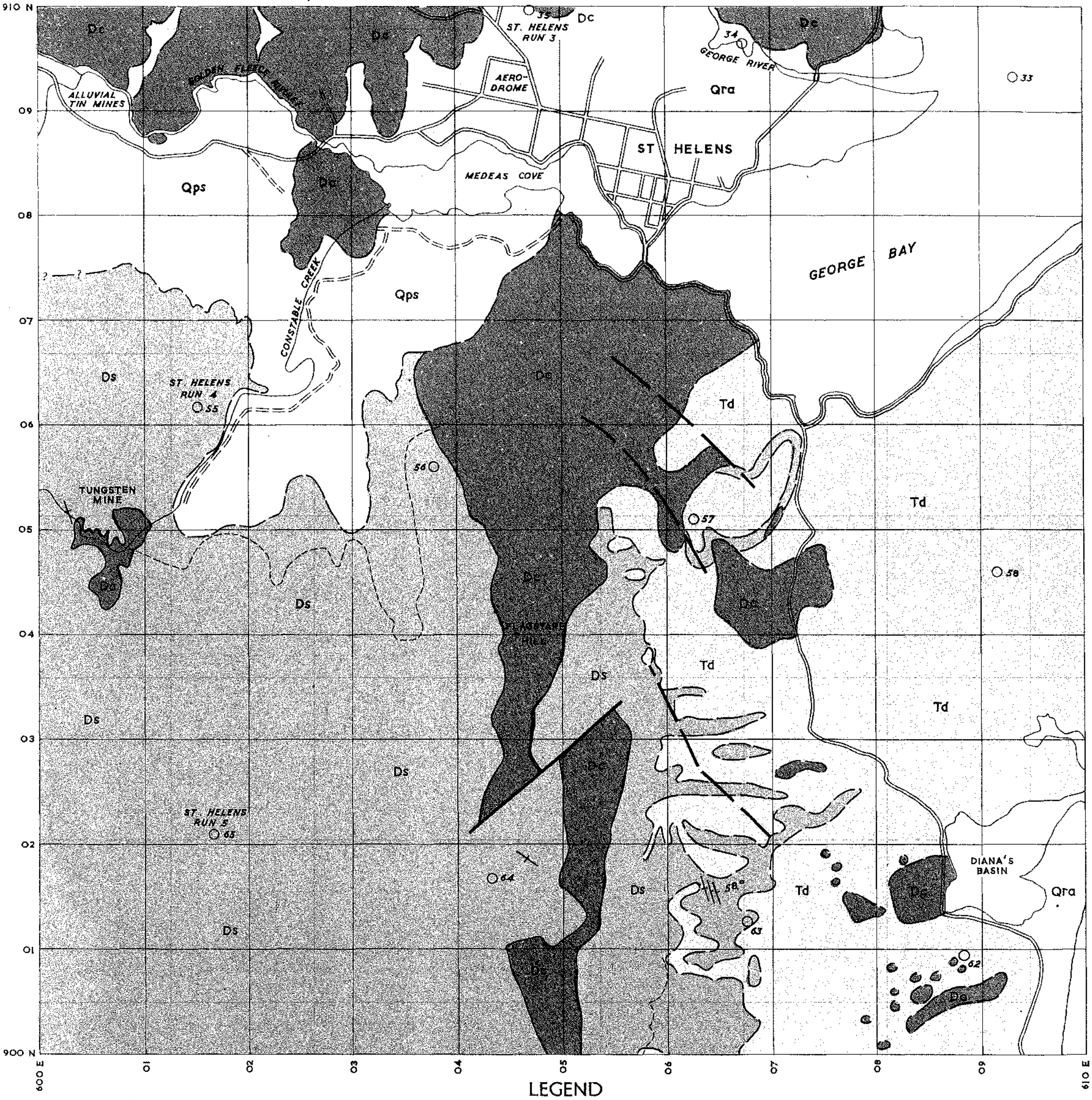
ST. HELENS

6090



LEGEND

FAULT WITH DOWNTHROWN SIDE INDICATED (D / U)

PHOTO — INTERPRETED FAULT

ESTABLISHED BOUNDARY — POSITION ACCURATE

ESTABLISHED BOUNDARY — POSITION APPROXIMATE

STRIKE AND DIP

ROADS

VEHICULAR TRACK

TRACK

BRIDGE

PHOTO CENTRE

VERTICAL DIP

Quaternary System

RECENT SERIES

Qra — ALLUVIUM

PLEISTOCENE SERIES

Qps — ST. HELENS CLAYS AND GRAVELS

Tertiary System

Td — DIANA'S BASIN SANDS AND GRAVELS

Mathinna Group

Ds — SCAMANDER SLATE AND QUARTZITE

IGNEOUS ROCKS

Dc — COASTAL RANGE QUARTZ MONZONITE

Compilation from Aerial Photographs. Trigonometric Station Control by courtesy Lands and Surveys Dept. Origin of co-ordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7.

— SCALE —

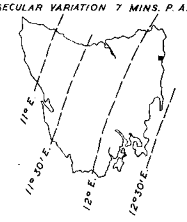
0 — 1 — 2 MILES

0 1 2 3 4 5,000 10,000 FEET

MAPPED AND COMPILED BY

K. R. WALKER 1953

KEY MAP SHOWING MAGNETIC DECLINATIONS
SECULAR VARIATION 7 MINS. P. A.



GEOLOGY OF ST. HELENS.
SHEET 6090

PHYSIOGRAPHY.

There are four physiographic units in this area. The south-west is an area of deeply dissected Scamander Formation and granite. This rises to about 1,500 feet in the west and is probably part of an uplifted surface dipping east. The streams in this area are in mountain tract and form a trellised drainage, the details of the stream courses being controlled partly by bedding but dominantly by jointing. The topography is late youthful or early mature. East of this is the coastal plain rising landward to 350 feet above sea level and covered with a veneer of sediments. This is dissected by streams flowing east to the sea which have cut valleys up to 150 feet deep. On its eastern boundary this drops sharply from 170 feet to the third unit, the lagoon and swamp area behind the beach ridges, the ridges themselves and the beaches. The coastline consists of long sweeping sandy beaches with rocky headlands and several islands off-shore. The coastal plain may have extended to the west and south-west of St. Helens up Constable Creek and Golden Fleece Rivulet. Around St. Helens itself is a fourth area only a few feet above sea level which is a flat alluvial plain.

STRATIGRAPHY.

The Scamander Formation occupies large parts of the area and consists of slates and quartzites for the most part. In the area to the south primitive land plants and fragmental marine fossils occur.

Unconformably on the Scamander Formation and Coastal Range Quartz Monzonite is the Diana's Basin Sand and Gravel. This forms a veneer on the coastal plain up to 350 feet above sea level and is at least 150 feet thick. In many places it is capped by a ferruginous granule conglomerate.

In the immediate vicinity of St. Helens Thureau's Deep Lead extends to 200 feet below sea level. The sediments in the Deep Lead and surrounding areas are called the St. Helens Clay and Gravel and contain some tin.

IGNEOUS ROCKS.

The only igneous rock in the area is the Coastal Range Quartz Monzonite with its associated differentiates. Contacts with intruded sediments are sharp but just north of Diana's Basin the intrusion has produced plastic deformation of the sediments. The monzonite contains andesine, microcline, quartz, biotite and hornblende with some orthoclase, apatite, muscovite and other minerals in small amounts. Numerous textural variations occur. Transgressing the quartz monzonite are dykes of diorite porphyry which consists essentially of labradorite and hornblende.

STRUCTURAL GEOLOGY.

West and immediately east of the Coastal Range the Scamander Formation has been folded along axes trending N15°-20°E and somewhat overturned to the east. On the coast north of Diana's Basin, however, the strike is consistently N55°W and the dip is very steep with some intricate overfolding to the north, some of the folds being recumbent and open to the south. Faulting can rarely be demonstrated but a north-easterly trending fault displaces the monzonite stock about a mile south of Flagstaff Hill (605E.902.8N).

ECONOMIC GEOLOGY.

Wolframite is being worked on the upper part of Constable Creek. It occurs in veins with quartz, scheelite, molybdenite and bismuth. The veins which are not more than 6 feet thick strike 285° and are mainly in the quartz monzonite but in places cut the country rock where some cassiterite is developed.

Thureau's Deep Lead has been tested and found to contain tin which has been worked in some of the subsidiary leads. At Goshen tin occurs in wash overlying granite and in the overburden. Some wolframite also occurs with it.

White clays occur in tin workings and on the southern headland of George's Bay.

POINTS OF SPECIAL INTEREST.

Intrusion of granite and folding on first headland north of Diana's Basin.
Sediments on southern headland of George Bay.
Tungsten Mine on Constable Creek.

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